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GEOLOGY
OF THE
ENGLEHART–EARLTON AREA
DISTRICT OF TIMISKAMING

By
H. L. LOVELL

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TABLE OF CONTENTS

	Page
Abstract	v
Introduction	1
Previous Geological Work	1
Field Work and Acknowledgments	1
Topography and Drainage	2
Resources	2
General Geology	2
Precambrian	2
Early Precambrian (Archean)	2
Metasediments (Pontiac)	2
Mafic and Intermediate Metavolcanics (Keewatin)	4
Mafic to Ultramafic Intrusive Rocks (Haileyburian)	4
Felsic Intrusive Rocks (Algoman)	4
Mafic Intrusive Rocks (Matachewan)	4
Middle Precambrian	5
Huronian Supergroup	5
Cobalt Group	5
Gowganda Formation	5
Coleman Member	5
Firstbrook Member	5
Mafic Intrusive Rocks	5
Nipissing Diabase	5
Late Precambrian	6
Mafic Intrusive Rocks (Keweenawan)	6
Phanerozoic	6
Paleozoic	6
Middle and Upper Ordovician	6
Lower and Middle Silurian	7
Cenozoic	7
Quaternary	7
Pleistocene and Recent	7
Structural Geology	8
Faults	8
Folds	8
Economic Geology	8
Water	8
Limestone	10
Description of Properties	10
Armstrong Township	10
Belanger, P.	10
Brethour Township	10
Brethour Township, Con. I, Lot 10	10
Dominion Gulf Corporation (1953)	10
Ingram Township	10
Marshall, F.D. and Marshall, J.A.	10
Peerless Canadian Exploration Occurrence Circa 1953	11
Pense Township	12
Armstrong; Cumming, R. Occurrence (1953)	12
Canadian Nickel Occurrence (1968)	12
Gereghty, G.J. and Waddell, L.A. Circa 1970	12
Hudson Bay Mines, Limited, The	12
Johnston, R.F.	12
Wabi River Mining Syndicate Occurrence (1969)	12
References	13

TABLES

1. Table of Lithologic Units	3
2. Properties for which Assessment Data is on File	9

PHOTOGRAPH

Frontispiece. Airphoto mosaic of the Englehart-Earlton area vi

GEOLOGICAL MAP

(back pocket)

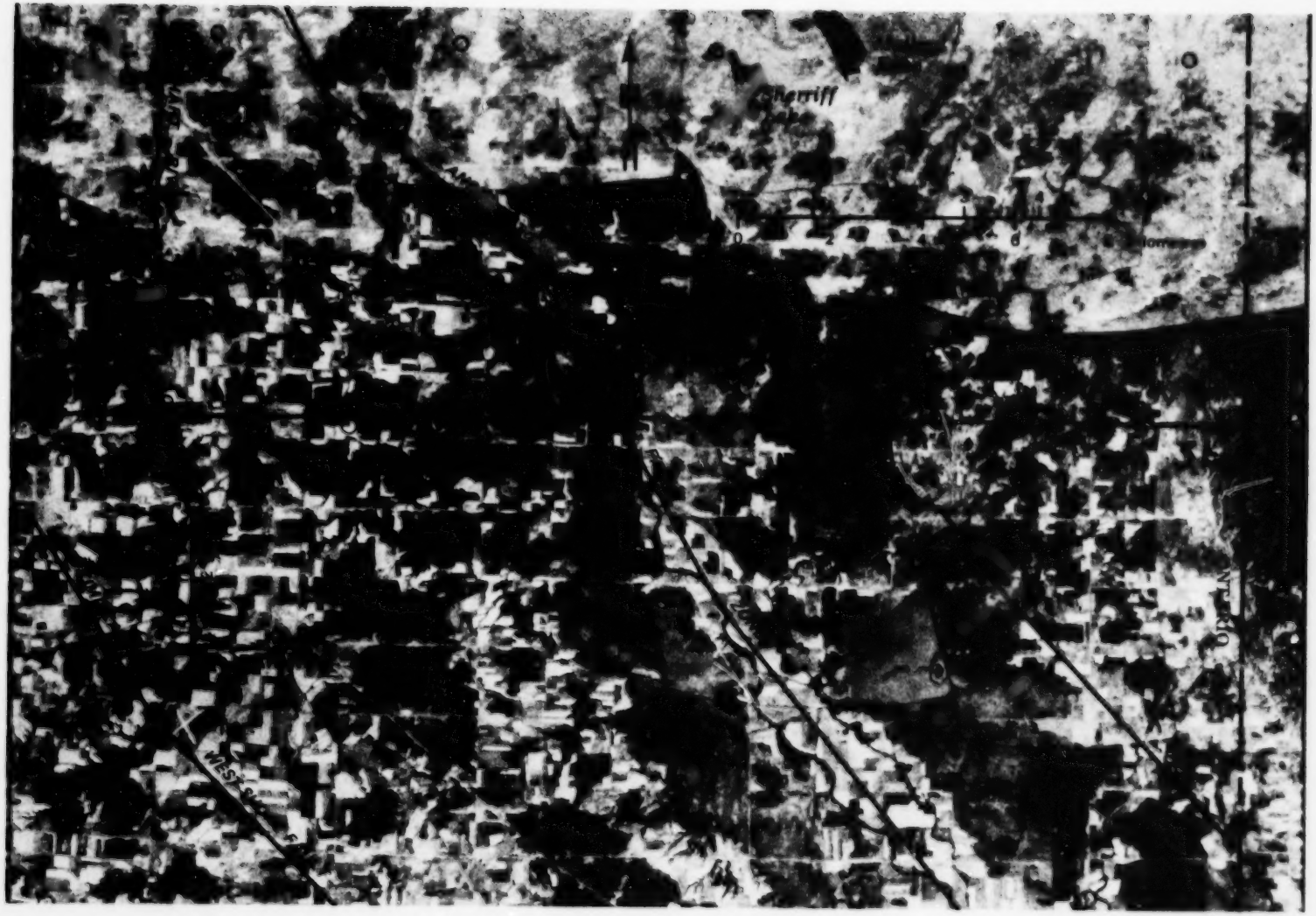
Map P.1249 — Geological Map of the Englehart-Earlton Area.
Scale 1 inch to ½ mile (1:31,680).

ABSTRACT

The Englehart-Earlton area comprises six adjacent townships each being six miles square (90 km^2), extending westward from the Ontario-Quebec boundary between the silver-mining community of Cobalt and the gold-mining community of Larder Lake, Ontario. The names of the townships are Evanturel, Ingram, Pense, Armstrong, Hilliard, and Brethour. Their economic mainstay at present is the agricultural industry established primarily on silt and clay soil deposited on the bed of glacial Lake Barlow-Ojibway, which formerly occupied the central trough of the Lake Timiskaming Rift Valley, a geomorphological expression of the most prominent bedrock structural feature in the map-area.

The main geological value of the Englehart-Earlton area to date is its Pleistocene sand and gravel, Paleozoic limestone road fill and metallurgical material, and picturesque geomorphological formations such as escarpments and a series of waterfalls at Kap Kig-Iwan Provincial Park caused by resistant Early Precambrian metavolcanic bedrock.

The potential for detection of concentrations of base metals seems confined to Pense and Brethour Townships where, unlike the other four townships, the Early Precambrian (Archean) rock formations are not completely covered by soil, flat-lying Paleozoic rocks, or Proterozoic sedimentary and intrusive rocks that are essentially barren of economic metals, with the possible exception of silver. Early Precambrian iron formation, associated with ultramafic rocks and metasediments, occurs in Pense Township, in the least accessible part of the map-area, and has not been explored extensively for base metals.



OGS 9719

Frontispiece – Airphoto mosaic of the Englehart-Earlton area showing typical glacial lake bottom farmland.

GEOLOGY

of the

ENGLEHART-EARLTON AREA

DISTRICT OF TIMISKAMING

by

H.L. Lovell[1]

INTRODUCTION

The map-area is midway between the Kirkland Lake gold-iron-copper and the Cobalt silver mining areas, and comprises the six adjoining townships of Evanturel, Ingram, Pense, Armstrong, Hilliard, and Brethour. The two eastern townships are along the Ontario-Quebec interprovincial boundary. In the map-area are the communities of Englehart and Earlton and the northern part of Thornloe, as well as adjacent agricultural and cottage-recreation areas, parts of which are favourable for mineral exploration. The Ontario Northland Railway main line passes through the three above-mentioned communities, with the station at Englehart and a branch line from Earlton to the station at Elk Lake, a community west of the map-area. Excellent access is provided to all but the northeastern part of Pense Township by Highways 11, 571, 562, 569 and 640, and by concession, lot line, and bush roads, the Ontario Northland Railway main line, the Englehart and Blanche Rivers, and Pontleroy Creek. The map-area is traversed diagonally from northwest to southeast by the Blanche River, navigable the entire distance by small boats without portaging.

Utilities in the map-area are high voltage electric power, the Trans Canada natural gas pipeline (recently twinned), and telephone lines.

Mineral production from the map-area has been confined to construction materials — sand, gravel, and limestone. In addition to use as road and airport runway fill, a small amount of limestone has been used in lime kilns. Known areas most favourable for metals exploration are those having the most exposures of Early Precambrian (Archean) bedrock, and they are the eastern parts of the two eastern townships (Pense and Brethour).

[1]Resident Geologist, Ministry of Natural Resources, Kirkland Lake. Manuscript approved for publication by Chief Geologist, Geological Branch, 18 October, 1976. This report is published by permission of E.G. Pye, Director, Geological Branch.

Previous Geological Work

A map and a report of the Blanche River area by A.G. Burrows and P.E. Hopkins were published by the Ontario Department of Mines in 1922. The map and report concern 26 townships, including all the present map-area. The Paleozoic outlier of Lake Timiskaming, Ontario and Quebec, was described in a report by G.S. Hume published by the Geological Survey of Canada in 1925. A soil survey of New Liskeard-Englehart area, consisting of a map and a report by Hoffman, Wicklund, and Richards was published in 1952 by the Dominion Department of Agriculture and the Ontario Agricultural College. The map illustrates the soil cover in 26 townships including all the present map-area. "Algoma, Sudbury, Timiskaming, and Nipissing surficial geology" by Boissoneau is a small-scale reconnaissance map published by the Ontario Department of Lands and Forests in 1965. "Lake Timiskaming Rift Valley" by Lovell and Caine was published by the Ontario Department of Mines in 1970.

Field Work and Acknowledgments

Base maps of townships were prepared from Forest Resources Inventory sheets by the Carto-

graphic Section, Surveys and Mapping Branch, Ontario Ministry of Natural Resources. The base maps were provided at the scale one inch equals one-quarter mile, as were air photographs. All townships, except Pense, were mapped by the author during the field season of 1972, with assistance mapping Evanturel Creek (Jean-Baptiste Creek) by G. Kasner. Pense Township was mapped by E.D. Frey assisted by Mr. Kasner.

Topography and Drainage

The relief in the map-area is low to moderate, with streams in deeply incised ravines in the clay soils. The highest elevation is more than 320 m (1050 feet) above mean sea level, on a ridge of Nipissing Diabase in north central Pense Township. The lowest elevation is less than 180 m (600 feet) above mean sea level and is located where the Blanche River flows southeast from the southern boundary of Brethour Township. The topographic contours on the geological maps accompanying this report are transcribed from contoured maps of the National Topographic Series at the scale 1:50,000. The main drainage systems are Evanturel Creek, the Blanche River, and Pontleroy Creek. The Blanche River for most of its length in the map-area follows an assumed fault of the Lake Timiskaming Rift Valley (Lovell and Caine 1970, p.2), and its tributaries form a rudimentary trellis drainage pattern by flowing straight downslope perpendicularly towards the Blanche River. The course of Evanturel Creek and the part of the Englehart River at Englehart community follow or are controlled by assumed faults striking north, which is the main direction of regional faulting other than that of the northwest-striking rift valley.

Resources

The Englehart-Earlton area is in the Little Clay Belt which comprises some of the best dairy and beef-raising farmland in northern Ontario. Earlton is a farming and airport town, and Englehart principally a divisional point on the Ontario Northland Railway. Tomstown, Thornloe, and Hilliardton are logging and farming hamlets. All the communities are neatly laid out on lowland clay soil that is devoid of exposed bedrock, but as far as is known they are underlain by Paleozoic sedimentary rocks or flat-lying Nipissing Diabase. Kap Kig-Iwan Provincial Park (with camp grounds) is within 3 km (2 miles) of Englehart. The Park is centred on a series of waterfalls caused by the water flowing over resistant Early Precambrian (Archean) iron-rich tholeiitic metavolcanic rocks. The name of the Park is Ojibway Indian for "high falls", referring to the cascade from the steeply dipping resistant volcanic flows and tuffs down onto the lower elevation of the easily eroded flat-lying Paleozoic limestones.

GENERAL GEOLOGY

The Englehart-Earlton area contains metavolcanic, metasedimentary and intrusive bedrock units of Early Precambrian (Archean) age, intrusive and sedimentary rocks of Middle Precambrian (Proterozoic) age, and sedimentary rocks of Paleozoic age. The Early Precambrian rocks lie on the southern margin of the Abitibi Belt that extends from Chibougamau to Wawa (Goodwin and Ridler 1970). The Middle Precambrian rocks comprise part of the Cobalt Plain (or Plate) that extends from Sudbury to Kirkland Lake (Card *et al.* 1972). The Paleozoic rocks are related to the Ordovician rocks of Lake Nipissing (Hume 1925, p.13) and the Silurian rocks of the James Bay lowlands and Manitoulin Island (Sanford *et al.* 1968).

Surficial deposits cover most of the bedrock. They consist of Pleistocene clay, sand, gravel, and glacial till. Recent deposits consist of alluvium and peat.

Precambrian

EARLY PRECAMBRIAN (ARCHEAN)

Metasediments (Pontiac)

Metasediments belonging to what has been called the Pontiac Group (Chagnon 1968) are exposed in Pense and Brethour Townships. These rocks consist of quartz-biotite gneiss and biotite-amphibolite schist and are composed mainly of quartz, biotite, hornblende, and white feldspar. The quartz is medium-grained and forms layers averaging about 1 cm thick which are interbanded with thin micaceous layers that impart schistosity to the rock. Hornblende is present both in the quartzose bands and with biotite. Quartz occurs also as augen, gash veins, ptygmatically folded quartz veins, and as rodding

TABLE 1 TABLE OF LITHOLOGIC UNITS FOR THE ENGLEHART-EARLTON AREA.

CENOZOIC
QUATERNARY
PLEISTOCENE AND RECENT
Till, varved clay, sand, gravel, peat

UNCONFORMITY

PALEOZOIC
LOWER AND MIDDLE SILURIAN
Thornloe (Clinton) Formation: limestone, dolomite, sandstone
Wabi Formation: limestone, shale

DISCONFORMITY OR PARACONFORMITY

MIDDLE AND UPPER ORDOVICIAN
Liskeard Group
Dawson Point Formation: shale
Farr Formation: limestone
Bucke Formation: limestone, shale
Guigues Formation: sandstone, conglomerate

UNCONFORMITY

PRECAMBRIAN
LATE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS (KEWEENAWAN)
Augite and olivine diabase

MIDDLE PRECAMBRIAN
MAFIC INTRUSIVE ROCKS (NIPISSING)
Granophyre, aplite, transition rock (varied texture diabase), quartz diabase (diorite), hypersthene diabase (including norite)

INTRUSIVE CONTACT

HURONIAN SUPERGROUP
COBALT GROUP
Gowganda Formation
Firstbrook Member: argillite
Coleman Member: conglomerate, quartzitic arkose, greywacke, argillite

UNCONFORMITY

EARLY PRECAMBRIAN (ARCHEAN)
MAFIC INTRUSIVE ROCKS (MATACHEWAN)
Diabase

FELSIC INTRUSIVE ROCKS (ALGOMAN)
Granitic rocks, syenite

INTRUSIVE CONTACT

MAFIC TO ULTRAMAFIC INTRUSIVE ROCKS (HAILEYBURIAN) AND POSSIBLE EXTRUSIVES
Serpentinite, gabbro and diorite

INTRUSIVE CONTACT OR DISCONFORMITY

MAFIC AND INTERMEDIATE METAVOLCANICS (KEEWATIN)
Mafic to intermediate tuffs and flows, chlorite schist, iron formation (magnetite cherty tuffs, carbonaceous sulphide-bearing schist) and pyroclastics

UNCONFORMITY, OR CONTACT METAMORPHIC ZONATION

METASEDIMENTS (PONTIAC)
Quartz biotite gneiss, biotite-amphibolite schist, mica-quartz-feldspar slate, greywacke

that is observable on a dip surface contrasted with pale coloured quartz and feldspar. In one place the biotite gneiss was observed to be cut by a mafic dike 10 cm (4 inches) wide, and elsewhere by sub-concordant sills of pale pink fine-grained felsite. Drilling in the area underlain by the metasediments has intersected thin iron formation (magnetite-chert?) interbedded with minor felsic tuff, slaty tuff and graphitic and sulphide-bearing schists.

In Pense Township, concession II, lot 10, hornblende syenite that might be a de-silicated peripheral phase of nearby granite has a gradational contact with the quartz-biotite schist.

Mafic and Intermediate Metavolcanics (Keewatin)

The majority of the metavolcanics are intermediate to mafic massive flows and banded tuffs. Most fresh surfaces are of whitish grey coloured plagioclase feldspar, with a few prominent green serpentine grains in places as alteration products from pyroxene. In Brethour Township the banded intermediate tuffs characteristically contain quartz lenses cutting across the banding. From the central part of Brethour Township eastward towards the large area of granitic rocks in Quebec (Chagnon 1968, map), the metamorphic grade increases. Mica replaces chlorite; quartz grains are coarsened as a result of recrystallization and occur as gash veins and augen; tuffaceous banding is rendered more distinct as a result, presumably, of metamorphic differentiation.

The relationship between the metavolcanics and the structurally underlying metasediments is particularly well illustrated in southeastern Brethour Township along Wright Creek. Judging from a series of outcrops on the stream banks, banded intermediate tuff seems to grade in an upstream (northeastward) direction into structurally underlying banded biotite gneiss. The gradational phase is intermediate gneissic tuff with bands of minerals that are slightly coarser grained, i.e. large enough to be distinguished from one another with the naked eye. The gneissic and coarser grained aspects of this gradational phase possibly result from metamorphic differentiation and recrystallization, as mentioned above. In any case the transition to biotite gneiss occurs towards the granitic batholith, to the east in Quebec, that is shown on the map accompanying Chagnon's 1968 report. By these changes the Keewatin-type metavolcanics grade imperceptibly into Pontiac-type quartz-biotite schists and gneisses.

Mafic to Ultramafic Intrusive Rocks (Haileyburian)

Coarse-grained mafic and ultramafic rocks apparently intrude the metasediments but contacts are not exposed in outcrop. These rocks have been interpreted as intrusive in places. The units appear to be discordant in attitude to the general strike of the metasediments. However, intercalation of some of these rocks with metavolcanics, as seen in drill core, indicates some to be flows and tuffs. The rocks are predominantly serpentinite but minor metamorphosed gabbro and diorite mineralogical compositions are represented.

Felsic Intrusive Rocks (Algoman)

In Pense and Brethour Townships granitic rocks are exposed in the eastern fault block of the Lake Timiskaming Rift Valley which is downthrown relatively the least and therefore represents deeper levels in the crust. They occupy only a small part of the map-area, i.e. the eastern part of Pense Township, and, as is the situation generally for "granite" of the Kirkland Lake-Englehart-Gowganda-Matachewan-Matheson area, are poorly exposed. In Pense Township the felsic intrusive rocks consist of oligoclase-microcline granite and hornblende syenite. The syenite occurs as a peripheral, possibly de-silicated phase of the granite, and in one outcrop in the southeastern part of Pense Township (concession II, lot 10) grades imperceptibly into quartz-biotite schist of the Pontiac Group.

In Brethour Township, concession I, lot 9, sub-concordant felsite sills (maximum thickness 3 m; 10 feet) were observed cutting biotite gneiss metasediments. The sills are pale pink in colour, with a spotty appearance resulting from anhedral feldspar phenocrysts a maximum of 2 cm in diameter.

Mafic Intrusive Rocks (Matachewan)

One dike of Matachewan Diabase was identified in the map-area, in Pense Township, concession III, lot 10. It is typical Matachewan Diabase as described by Lovell (1967, p.12) for the Matachewan area, with quartz gabbroic composition and diabasic texture.

MIDDLE PRECAMBRIAN

Rocks of Middle Precambrian age in the map-area belong to the Huronian Supergroup of generally flat-lying sedimentary rocks and Nipissing Diabase. The latter is a complex of intrusive rocks ranging through a differentiation series from hypersthene gabbro to granophyre.

Huronian Supergroup

COBALT GROUP

Gowganda Formation

COLEMAN MEMBER

The Coleman Member rocks form a continuous series gradational from coarse to finer epiclastic rocks, but have been arbitrarily subdivided on the following basis.

For purposes of this report, the Pettijohn (1957) classification of clastic sedimentary rocks was used. Thus what have been called conglomerates are those rocks containing lithic pebbles, cobbles, and boulders in which field identification of the source rock type e.g., granodiorite, mafic volcanic rock, is feasible with the naked eye. In contrast, the coarser fractions in the Coleman arkose, greywacke, and impure quartzite consist of clastic fragments for which the recognition of the mineral types (broken plagioclase, microcline, or quartz grains) requires the use of the mineral lens. The Coleman argillite consists of indurated silt, clay, and rock flour, in which the coarser broken clasts of feldspar, quartz, mica, etc. are recognizeable only by means of high magnification using the petrographic microscope.

In many places the Coleman conglomerate clasts consist predominantly of mafic volcanic pebbles and cobbles and the more conspicuous and perhaps larger but less numerous granitic pebbles and cobbles, a few of which have a maximum diameter of about 2 m (6 feet), but average only about 1 cm. Overall, the clasts represent a great variety of source rocks, some being gneissic (indicating deep erosion), and a broad range of sphericity and roundness.

In most places the matrix is greenish grey mudstone or greywacke, as is typical of those Coleman Member conglomerates in the Cobalt and Kirkland Lake areas that were deposited short distances down the glaciation direction from Early Precambrian mafic to intermediate metavolcanics and metasediments.

The bedding is thick and poorly defined, these characteristics being typical of the Kirkland Lake and Cobalt area tillites (Lindsey 1969, p.1689; Lovell 1967, p.14) as opposed to a bimodal type of conglomerate in the Cobalt area consisting of an intact framework of boulders, cobbles and pebbles, from a great variety of source rocks, in a matrix of well bedded greenish grey argillite most of which obviously was laid down from quiet waters. In some conglomerates the matrix is reddish arkose, particularly where a granitic or syenitic terrane is nearby and evidently constitutes the provenance of the matrix, regardless of the source of the pebbles, cobbles and boulders. The thickness of the conglomerate bed on the Belle Vallee cemetery's east side extends from the base of the cliff to the top of the hill, i.e. approximately 30 m (100 feet) thick.

Coleman Member greywacke differs from Coleman Member conglomerate in having very few cobbles and boulders, in containing lenses of pink quartzose arkose, and in having many steeply dipping fractures and quartz stringers, some bearing hematite.

FIRSTBROOK MEMBER

The Firstbrook Member is exposed in a small area of Brethour Township, concession II, lot 3. The rocks are well-bedded, having interlaminated dark red (maroon coloured) siltstone and dark grey claystone, each bed averaging 1 cm thick. The siltstone and claystone are made up predominantly of silt to clay-sized fragments of quartz, pink and white feldspar, and micas, all of which are cemented together by silica and iron oxide. The Firstbrook Member siltstone and claystone (i.e. argillite) appear as varved couplets possibly laid down on a glacial lake bottom (Thomson 1966, p.16).

Mafic Intrusive Rocks

(NIPISSING DIABASE)

Nipissing Diabase intrusions actually are complex, having hypersthene diabase, quartz diabase, transitional, and granophyric phases. All phases form a gradational series. The texture is diabasic in most parts of the hypersthene diabase and quartz diabase, but typically is sub-ophitic (prismatic pyroxene or acicular amphibole

crystals in a matrix or subhedral to anhedral feldspars) in the transition rock and micropegmatitic to hypidiomorphic granular (granitic) in the granophyric phase.

The Nipissing Diabase forms step-sided cone-shaped intrusions (Lovell and Caine 1970, p.12), which in plan view appear as patterns that are annular (ring dike), linear (feeder dike), or areally extensive (sills cutting flat-lying Cobalt Group sedimentary rocks). In some of the flat-lying sill portions the Nipissing Diabase contains vertical cylindroidal (cycloidal) jointing (Hester 1967). The rock inside (on the concave side of) the joint's curvature is called "columns" or "pillars" in mine terminology in the Gowganda area, where many of these joints are filled with calcite or dolomite veins bearing enough silver to constitute ore. In plan view the cylindroidal joints form an arcuate to almost closed circular pattern in parts of flat-lying sills where the long axes of the columns of rock enclosed by the cylindroidal joints are roughly perpendicular to the upper contact of the diabase intrusive.

Quartz diabase is the most abundant phase of diabase, and constitutes the basal, possibly original magmatic composition of sill portions of Nipissing Diabase. The quartz diabase typically is exposed as smoothly rounded outcrops with grey-and-black weathered surfaces that are slightly rough because of its content of resistant grains of white feldspar in a matrix composed mainly of hornblende replacing augite, and of augite itself.

The most dense, most mafic phase of Nipissing Diabase ("norite": Satterly 1933, p.4; i.e. hypersthene gabbro) is in the feeder dikes and in the lowest differentiated part of the Nipissing Diabase where the diabase forms a sill. Much of the hypersthene gabbro has diabasic texture, with resistant laths of subhedral to euhedral white plagioclase; the rock commonly is called hypersthene diabase. Many of the plagioclase laths are 3 or 4 mm long. The hypersthene occurs as blocky brown subhedral prismatic crystals averaging 2 mm diameter that are less resistant to weathering, so that, on weathered surfaces and joints, dark rusty pits mark the former location of weathered-out hypersthene grains. Quartz is present in places, in minor quantity. Olivine, where present, typically is rimmed by hypersthene. Accessory minerals include biotite, ilmenite, leucoxene, apatite, pyrite, pyrrhotite and chalcopyrite.

Above the hypersthene diabase in a typical differentiated sill (e.g. Ingram Township, concession VI, lot 7, near the gravel pit) is a phase of Nipissing Diabase that is transitional to granophyre. This transitional phase characteristically has a splotchy texture imparted by areas of coarse-grained mafic minerals (dark green pyroxenes and acicular black primary amphiboles) in a greyish white to pale pink feldspar matrix.

The youngest, uppermost differentiate of Nipissing Diabase is pink granophyre.

LATE PRECAMBRIAN

Mafic Intrusive Rocks (Keweenawan)

The assumed extension of a long narrow mafic intrusive dike enters Ingram Township near Mallard Lake from Bayly, the township north of Ingram. Lovell *et al.* (1976) group this dike with Nipissing Diabase, but its projected extension in Ingram Township crosses an area of Nipissing Diabase. Contacts are covered by overburden, but presumably the dike is either a feeder or a late phase of Nipissing Diabase, or else of some younger age, possibly Keweenawan.

Phanerozoic

PALEOZOIC

In the map-area the Paleozoic rocks of Ordovician and Silurian age comprise the north part of the Lake Timiskaming outlier. They have been described by Hume (1925) and by Lovell and Frey (1972). In the map-area the Paleozoic rocks form a northwest-trending area controlled mainly by central fault blocks of the Lake Timiskaming Rift Valley (Lovell and Caine 1970). Because of extensive soil cover of the farmland, that characteristically overlies the Paleozoic rocks, most of the area assumed to be underlain by Paleozoic rocks, particularly those of Ordovician age, is the result of interpolation between widely separated points of observation, including rudimentary descriptions of bedrock in water well drill logs (Ontario Water Resources Commission 1972).

Middle and Upper Ordovician

Ordovician rocks were observed only along the Englehart River in Kap Kig-Iwan Provincial Park about 3 km (2 miles) south of Englehart. The Ordovician rocks are limestones. The actual

contact zone is obscured by soil, but probably the limestone is in fault contact with the Archean metavolcanics, rather than lapping up against them. The limestone adjacent to the northwestern side of the fault dips about 15° NE, is thinly bedded (i.e. 2.5 to 7.5 cm; 1 to 3 inches thick) and the fossil population is of low concentration, with individual fossils mostly consisting of broken parts, indicative of a fairly high-energy environment.

Elsewhere in the map-area, Ordovician rocks are assumed to underlie some of the Silurian rocks, and were interpolated as connecting with Ordovician rocks identified in Casey Township (Thomson 1965). This interpolation was made originally by Hume (1925, p.5, figure 1). Ordovician rocks present in the region include the Guigues, Bucke, Farr, and Dawson Point Formations, which are described by Lovell and Frey (1972, p.21-23).

Lower and Middle Silurian

Silurian rocks underlie much of the claybelt farmland, but as for the Ordovician rocks, are generally flat-lying and poorly exposed. The contact between Ordovician and Silurian is not exposed in the Englehart-Earlton area, nor has a hole been drilled through both formations, except 21 km (13 miles) south of the map-area in Harris Township (Thomson 1965, p.27), but their relationship may be disconformable or paraconformable.

The Silurian rocks belong to the Wabi and Thornloe Formations as described for the New Liskeard area by Lovell and Frey (1972, p.24-26), and typically contain abundant fossils consisting mainly of corals, crinoids, ostracods, brachiopods, cephalopods, bryozoans, and stromatoporoids. The Wabi Formation, where exposed on the beds of Evanturel Creek and the Englehart River near their confluence, tends to be thin-bedded (average about 5 cm; 2 inches thick). It contains shaley beds that are thin for the most part, but at the falls by the bridge in Evanturel Township, concession III, lot 9 attain a maximum thickness of about 30 cm (1 foot). The Thornloe Formation overlies the Wabi Formation, and is exposed mainly in Armstrong Township along the northwest-trending ridge. The Thornloe Formation (Lockport Formation of Hume 1925) is separated from the underlying Wabi Formation by a slight disconformity (Hume 1925, p.34). The Thornloe Formation is more dolomitic and thick bedded (average 15 cm; 6 inches) than the Wabi Formation, with lenses of chert. It contains numerous fossils of corals.

CENOZOIC

Quaternary

PLEISTOCENE AND RECENT

Most of the surface of the Englehart-Earlton area consists of flat-lying varved silt and clay of the Little Clay Belt. The silt and clay were deposited on the bottom of glacial Lake Barlow-Ojibway, which developed about 10,300 years B.P. and finally drained away from the map-area about 8,700 years B.P. (Prest 1970, p.720-722). In the intervening time deciduous, coniferous, and other types of vegetation have developed on the average 15 to 60 cm (½ to 2 feet) of brown forest, grey wooded, podzol, and dark grey gleisolic topsoils. The maximum depth of soil from the surface at the A_1 horizon and including all the B horizon, in which most soil geochemical exploration is done to prospect for metals other than those in basal till, is about 1 m (3 feet) (Hoffman *et al.* 1955, p.25-27). As contrasted with the Great Clay Belt (Timmins, Cochrane etc.), which was denuded of glacial ice more recently and slopes more gently, the Little Clay Belt has deep ravines incised into it, even by small ephemeral rivulets.

Many hilltops in the Englehart-Earlton area are of lake bottom clay soil and esker delta gravel, and are underlain by basal till of the Wisconsinan ground moraine. This type of soil cover on the hills indicates that their elevations are lower than high water levels of glacial Lake Barlow, and the lake level dropped too rapidly below the highest hilltop elevations to erode away the sediments deposited on the glacial lake bottom and as a result leave only the ground moraine (basal till). At slightly lower elevations, e.g., about 210 m (700 feet) above sea level, bare bedrock is exposed. This indicates that the glacial lake fluctuated at about this level for a period of time long enough to wave wash down through lake bottom clay, esker delta sand and gravel, and underlying ground moraine ablation and lodgement till to expose the bedrock. This complete Pleistocene soil profile was intersected in some of the water well drilling in the area, as indicated by logs of the drilling (Watt and Jeffs 1963, p.293). Where the boulder till was the site of a temporary beach of glacial Lake Barlow, a

lag concentrate of boulders and pebbles is present.

Above the soil laid down during Pleistocene time, black muck or peat has developed in wet areas during Recent time, and sand and gravel bars as well as (in more tranquil waters) silt and clay have been deposited on recent river beds.

Striae trending towards 165° Az. related to the James Bay centre of glaciation (Prest 1970, p.734), predominate in the Englehart-Earlton map-area, but striae trending towards 255° Az. related to the Quebec centre of glaciation (Prest 1970, p.733), also were found as in Evanturel Township, concession I, lot 10, the northernmost such occurrence mapped at present in Ontario.

STRUCTURAL GEOLOGY

Faults

The most prominent faults in the Englehart-Earlton area are those of the Lake Timiskaming Rift Valley (Lovell and Caine 1970). The rift faults strike northwest and bound the downdropped blocks that controlled the distribution of glacial Lake Barlow-Ojibway and consequently the silt and clay lake bottom sediments that have become the best farmland. The Lake Timiskaming West Shore Fault, the northeastern side of which is downdropped, causes the escarpment that extends from the towns of New Liskeard and Haileybury in the south, to the southwestern part of the map-area west of Earlton airport. The Blanche River Fault zone, also of the Lake Timiskaming Rift System, strikes northwest through Hilliard and Ingram Townships.

Parts of the courses of Evanturel Creek and Englehart River flow north along a distinct lineament which probably marks the location of an extension of the fault that is under the Munro Esker east of Kirkland Lake, and that contains a strong aquifer. Englehart's municipal water supply is derived from wells near the probable fault, and to the south Earlton's wells are about 2.5 km (1½ miles) east of it, still in the fault valley.

Folds

Early Precambrian (Archean) rocks in the map-area dip steeply and are curved around the northwest-extending part of the large granitic massif in the adjoining part of Quebec Province (Chagnon 1968, map).

According to Card *et al.*, 1972, the Proterozoic rocks in the map-area form part of the Southern (structural) Province of the Canadian Precambrian Shield. However, dips in the central parts of the basins of the Gowganda Formation in the map-area are gentle; only at the edges of the basins, near the contacts, and also where dragfolded by faulting, do the beds dip steeply (maximum 60°). Presumably the steep dips near the edges of basins are a result of compaction of the sediments during induration rather than a tectonic phenomenon. In addition the dips of Gowganda Formation beds in some places near diabase intrusions have been steepened.

The main structural feature of the Paleozoic rocks is their shallow homoclinal dip southwest towards the northwest-striking Lake Timiskaming West Shore rift valley fault.

ECONOMIC GEOLOGY

Because of the extensive cover of soil and flat-lying Paleozoic and Proterozoic sedimentary rocks over the Early Precambrian rocks, which are the most favourable for concentrations of base metals, prospecting has been confined mainly to Pense Township, where the Early Precambrian (Archean) rocks are best exposed. However, showings of silver, lead and copper have been found in Ingram Township associated with possible feeder dike of the Nipissing Diabase. Also, limestone from quarries in Armstrong Township has been used for road fill and, in the early days of settlement of the farmland, for manufacturing lime in local kilns.

Sand and gravel have been obtained from all of the map-area townships to use for road building and other construction, and large quantities are still available, particularly in the upstream (northern) parts of esker deltas in Ingram and Pense Township.

Water

The major rivers, creeks, and also the ground water courses percolating through overburden all generally follow depressions in bedrock. The bedrock depressions are along the main faults, the main sets of faults being those striking north and northwest. Surface water manifestations of this control exerted by bedrock fault features include the north-flowing parts of Evanturel Creek and the Englehart River (near the town of

TABLE 2 PROPERTIES FOR WHICH ASSESSMENT DATA IS ON FILE WITH THE ONTARIO MINISTRY OF NATURAL RESOURCES, KIRKLAND LAKE, AS OF NOVEMBER 1976.

Property Number	File Name	Date of Work	Type of Work	No. of Drill Holes	Feet Drilled	Township
6	Armstrong; Cummings, R.	1953	GL			P
1	Belanger, Pierre	1946, 1953	GL			A
2	Brethour Tp. con.I, lot 10	1962	GL			B
7	Canadian Nickel	1968	DD	1	225	P
3	Dominion Gulf	1952, 1953	DD,EM, GL	2	815	B
11	Dominion Gulf	1954	GL,Mag			P
4	Fox Lake	1962	DD,GL	4	449	I
8	Gereghty & Waddell	1969, 1970	DD	6	1,753	P
9	Hudson Bay Mines (The)	1972	DD	1	327	P
10	Johnston, R.F.	?	GL			P
4	Marshall, F.D. & Marshall, J.A.	1920, 1937, 1953-1973	DD,GL	36	6,006	I
5	Peerless Canadian	*Circa* 1953	GL			I,P
11	Wabi River Mining Syndicate	1950, 1958, 1959, 1968, 1969	DD,EM, GL,Mag	14	1,666	P

Abbreviations Used:

DD - Diamond drilling
EM - Electromagnetic
GL - Geological
Mag - Magnetic

A - Armstrong
B - Brethour
I - Ingram
P - Pense

Englehart), and the main southeast-flowing part of the Blanche River. The most obvious subsurface examples of the control include the linear distribution of kettle lakes along the Cross Lake Fault in Beauchamp, which is the township west of the map-area township of Armstrong, and the distribution of artesian and other wells and springs in the southeast-striking Earlton and Blanche River valleys.

The municipal water supply for Englehart is from wells beside the above mentioned fault-controlled part of the Englehart River, and that for Earlton is 2.5 km (1½ miles) east of the southern extension of the same fault zone.

Limestone

Most of the limestone outcrops in the map-area are Silurian rocks, which are generally not low enough in magnesium to be chemically highly reactive and therefore can be used mainly as rock fill. Limestone from the quarry in Armstrong Township, concession II, lot 11 was used as a base for the Earlton airport runways. This quarry is in the side of the Lake Timiskaming West Shore Fault escarpment. The quarry in Armstrong Township, concession VI, lot 7 was used as road fill for Highway 11. About 1920 a small kiln in Armstrong Township, concession II, lot 1 was operated occasionally for local use by David Bass (Burrows and Hopkins 1922, p.18). Fragments 12 cm (5 inches) long were burned in a small kiln that had a capacity of 200 bushels in 96 hours.

Description of Properties

ARMSTRONG TOWNSHIP

Belanger, P. (1)[1]

The farm, now owned by Pierre Belanger, is located in Armstrong Township, concession II, lot 12, N½. Glacial lake bottom clays and recent deposits are widespread, but in the northwestern part of the property Nipissing Diabase outcrops. A pit was sunk in 1946 to a depth of 7 m (22 feet), without reaching bedrock, but it exposed some gravel similar to gravel from which gold was panned nearby (Robb 1946). A second pit (circa 1953) was sunk by R.J. Tinney into Nipissing Diabase, well jointed with quartz-calcite veins. The quartz-calcite veins are sparsely mineralized with chalcopyrite and assayed trace gold (Savage 1953).

BRETHOUR TOWNSHIP

Brethour Township, Con.I, Lot 10 (2)

In a brief note by R. Thomson (1962) mention is made of a pit and some trenches containing calcite veins in mica schist (possible felsic volcanics originally).

Mineralization consists of minor pyrite and chalcopyrite.

Dominion Gulf Corporation [1953] (3)

Geology: Exposures consist of Nipissing hypersthene diabase, massive and well jointed, overlying Cobalt sedimentary rocks composed of greywacke that is coarse-grained with fine-grained interbeds. The diabase-sediment contact dips about ten degrees east. Drilling intersected sediments, tuffaceous iron formation and quartz diabase. Electromagnetic conductors indicate the Nipissing Diabase forms a domal structure (Ratcliffe 1952).

Economic Features: The tuffaceous iron formation contains disseminated magnetite with minor pyrite and chalcopyrite (Burke 1953 and MacIntosh 1953).

History: The occurrence consisted of eight unpatented claims in Brethour Township, concession II, lots 3 and 4. Geological and electromagnetic surveys were done in 1952, two holes drilled in 1953 (265 m; 815 feet), by Dominion Gulf Company a wholly-owned subsidiary of Gulf Oil Corporation (Burke 1953; MacIntosh 1952; 1953; and Ratcliffe 1955). In 1976 the claims were open for staking.

INGRAM TOWNSHIP

Marshall, F.D. and Marshall, J.A. (4)

(Part of the former Tinex Development Exploration deposit)

Geology: The property is almost entirely covered

[1]The number in parenthesis refers to property number on Map P.1249, back pocket.

by deep overburden except for a ridge of Nipissing Diabase about 600 m (2,000 feet) wide extending westwards for about 750 m (2,500 feet) from Mallard Lake. Drilling intersected Cobalt Group sedimentary rocks (argillite, greywacke, conglomerate) and black shales.

Economic Features: The main mineralization comes from two quartz-calcite veins though smaller veins are present. The "Silver Vein" in Ingram Township, concession VI, lot 10, S½, a narrow quartz-calcite vein containing cobalt bloom, gave the following assays from a surface sample containing gold 0.38 ounces per ton, silver 0.65 ounces per ton and cobalt 4.50 percent, and a drill intersection of 30 cm (1 foot) containing gold 0.05 ounce per ton and silver 86.9 ounces per ton (Gerrie 1954). The "Galena Vein" in Ingram Township, concession VI, lot 11, S½, is a quartz-calcite vein containing small masses of galena which ran 4 ounces silver per ton, and a drill intersection over 30 cm (12 inches) assayed lead 22.43 percent, zinc 2.01 percent, silver 3.77 ounces per ton and 0.03 ounce gold per ton (Gerrie 1954). A chipped sample from a cross fracture on surface gave the following assay: lead 0.24 percent, cobalt 0.41 percent, copper 0.36 percent, zinc trace, silver 1.72 ounces per ton and gold 0.98 ounces per ton; other samples gave higher base metal contents but much lower gold values (Bayne 1962).

History: Burrows and Hopkins (1922) reported prospecting *circa* 1920, during which time two veins were revealed, on one of which a shaft 12 m (40 feet) deep was dug together with other pits. This work was done following the silver discoveries at Cobalt, when diabase was being followed westward and northward from that area.

In 1937 the "Galena Vein" near the centre of concession VI, lot 11, S½, SW¼, was developed by J.A. Marshall for a length of 60 m (200 feet). In 1951 Sylvanite Gold Mines, Limited examined the Martin Group (LeBoeuf) of ten claims on which the "Galena Vein" occurs but did not consider them to be of any interest (Anon. 1951). During 1953? three short holes (38 m; 121 feet) were drilled into diabase. In 1953 the claims were acquired by G.E. Harrison, who sold them in 1954 to Hamason Mines Limited. This company was incorporated in 1954 and its charter was cancelled in 1960 (Canadian Mines Handbook, 1963, p.79 and 283). The company did considerable prospecting and drilled three holes (34 m; 122 feet) on the "Silver Vein" (Gerrie 1954).

In 1961 MacDor Quebec Mines, Limited (incorporated 1945) acquired four claims, three covering a portion of the old Hamason Mines Limited property, and staked ten additional claims. In 1961 Lagava Minerals Limited was re-named Fox Lake Mines Limited (Canadian Mines Handbook, 1962, p.94) and held six unpatented claims plus a half square mile of patented land; four of the unpatented claims were part of the Martin Group (LeBeouf). In 1962 four holes (137 m; 449 feet) were drilled (Bayne 1962). In 1962 Tinex Development Exploration Limited (incorporated 1950) acquired ten claims from Macdor Quebec Mines Limited. Con-Key Mines, (incorporated 1945) purchased a half interest in the deposit of Tinex Development Exploration Limited. During 1963 Tinex Development Exploration Limited drilled 19 holes (774 m; 2,538 feet) (Holbrooke 1963).

Foster D. and James A. Marshall acquired four claims (L105493, T264383, -84, -85) in 1965 and during the years 1966, 1967 and 1973 drilled 11 holes (1075 m; 3,525 feet) intersecting diabase and Cobalt sedimentary rocks (Marshall, Marshall, and Marshall 1966-73). In November 1976 the only two claims remaining in good standing are concession VI, lot 10, S½, NW¼ and SW¼, belonging to the Marshalls.

Peerless Canadian Exploration Occurrence Circa 1953 (5)

Geology: Most of the property is covered by overburden consisting of clay and gravel, the bedrock forming a depression, due in part to faulting. The only outcrops occur along the east shore of Mallard Lake in Bayly, the township north of Ingram, and consist of Cobalt sedimentary rocks (conglomerates and greywackes) striking south and dipping 5° west.

Economic Features: No mineralization is on record in the files acquired by the Resident Geologist, Ontario Ministry of Natural Resources, Kirkland Lake.

History: Peerless Canadian Exploration, Limited was incorporated in 1953. The property consisted of 11 unpatented claims in the northeastern corner of Ingram Township and 7 in the adjoining townships of Bayly, Mulligan and Pense.

The Company's charter was cancelled in 1972 (Canadian Mines Handbook, 1972-73,

p.263). In 1976 the claims were open for staking.

PENSE TOWNSHIP

Armstrong; Cumming, R. Occurrence 1953 (6)

In a short note R. Thomson (1953) described small trenches in Nipissing diabase, Pense Township, concession II, lot 6, N½, NW and SW¼, containing quartz-calcite veins with minor galena and chalcopyrite. Diabase is exposed also in contact with Cobalt conglomerate, in small pits containing a little cobalt bloom. In 1976 the claims were open for staking.

Canadian Nickel Occurrence 1968 (7)

Geology: The property is covered by overburden. Drilling intersected felsic and mafic metavolcanics and graphitic schist.

Economic Features: Sulphide mineralization was reported (Brown 1968) from felsic and mafic metavolcanics and graphite (i.e. carbonaceous) schist containing pyrite and pyrrhotite.

History: In 1968 Canadian Nickel Company, Limited, a wholly owned subsidiary of The International Nickel Company of Canada, Limited, drilled one hole (68 m; 225 feet) on old claim number T60551 in Pense Township, concession V, lot 11, S½, SW¼, In 1976 the claims were open for staking.

Gereghty, G.J. and Waddell, L.A. Circa 1970 (8)

Geology: The property is covered by overburden. Drilling intersected Early Precambrian mafic volcanics, mica and mineralized graphitic schists, and peridotite overlain by Huronian sediments.

Economic Features: About 10 m (30 feet) representative of core from sedimentary rocks containing quartz stringers was assayed and gave the following values: zinc 1.93 percent, copper 0.18 percent, gold 0.01 ounce per ton and silver 0.07 ounce per ton. Sulphide mineralization consisted of pyrite, pyrrhotite and minor chalcopyrite (Gereghty 1970).

History: During 1969-1970 six holes were drilled (534 m; 1,753 feet) (Gereghty 1970). The property is in Pense Township, concession V, lots 9 and 10, S½. In 1976 the claims were open for staking.

Hudson Bay Mines, Limited, The (9)

Geology: The claim is covered by overburden. Drilling intersected mafic, felsic and mineralized graphitic tuffs cut by a lamprophyre dike.

Economic Features: The mineralized graphitic tuff contains pyrite, pyrrhotite and minor chalcopyrite. The best assay given was gold trace and zinc 3.46 percent (Waddell 1972).

History: The Hudson Bay Mines, Limited was incorporated in 1909. In 1972 one hole (100 m; 327 feet) was drilled (Waddell 1972) in Pense Township, concession V, lot 9, N½, SE¼ (formerly claim L212581). In 1976 the claim was open for staking.

Johnston, R.F. (10)

The property consists of a quarter square mile of patented land owned by R.F. Johnston, in Pense Township, concession VI, lot 7, S½. Rock exposures consist of Nipissing Diabase cut by quartz veins. Some pitting was done (date not known). Ore samples were assayed but no values, nor what was assayed, are on record, only the statement "assays indicated considerable value" (Johnston 1967).

Wabi River Mining Syndicate Occurrence 1969 (11)

Geology: The property is largely covered by overburden, although small outcrops occur. A 600 by 900 m (2,000 by 3,000 feet) wide peridotite body trends west across the southeastern half of the property and is bounded by schists of sedimentary origin and cut by a gabbro dike trending north (probably Matachewan Diabase). The western half contains a larger amount of mineralized graphite shale, which is flanked by pink quartzites.

Economic Features: Mineralization consists mainly of narrow lenses of sulphides in Pontiac-type shales and schists (some of the latter graphitic) near contacts with mafic to ultramafic rocks. The sulphides appear to be structurally controlled, having been introduced either contemporaneously with the sedimentary rocks or during the shearing of the sediments (Sampson 1969). The sulphide

zones seem to be quite narrow (Ratcliffe 1954). The sulphides are pyrite and pyrrhotite with minor sphalerite, chalcopyrite and galena. Only a few assays are given, the best being copper 0.10 percent, nickel 0.04 percent, zinc 1.22 percent and silver 0.03 ounces per ton (Sampson 1969).

Asbestos fibres 1/8 inch long were found in serpentinized peridotite, but were not explored further because Dominion Gulf's ground magnetometer survey found no appreciable magnetic zone.

History: L. Shortt, *circa* 1950, dug pits in Pense Township, Con. III and IV, Lots 10 and 11, exposing carbonaceous (graphitic) mica schist. In 1954 Dominion Gulf Company, a wholly owned subsidiary of Gulf Oil Corporation, carried out a ground magnetometer survey. In 1958 Talisman Mines Limited acquired two claims from E. Verrier and staked 18 adjoining claims and carried out magnetic and electromagnetic surveys on part of the old Dominion Gulf property, and also did some packsack drilling (Geisler 1959) (no record of drilling in Resident Geologist's files, Ontario Ministry of Natural Resources, Kirkland Lake).

R.A. Geisler, 1959, drilled three holes (46 m; 152 feet) in Pense Township, Con. III, Lot 11. E. Verrier, *circa* 1968, drilled eight holes (150 m; 490 feet) on adjacent claims.

In 1968 Wabi River Mining Syndicate acquired claims covering all or parts of Pense Township, Con. III and IV, Lots 7 through 11 and carried out electromagnetic and magnetic surveys which led to option by Rio Tinto Canadian Exploration Limited (Gereghty 1970A). In 1969 Rio Tinto did magnetometer, gravity, horizontal loop electromagnetic surveys, and 3 holes (327 m; 1,074 feet) were drilled (Sampson 1969). In 1976 the claims were open for staking.

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MAPS
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CARTES
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